Efficient Energy Harvesting Suspension System for Electric Vehicles

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Problem Statement

Electric vehicle manufacturers and eco-conscious consumers struggle with energy efficiency and range. Our Efficient Energy Harvesting Suspension System addresses this by converting kinetic energy from suspension movement into usable electrical energy. Unlike traditional systems that rely on external power, our solution captures energy directly from the vehicle's motion. This not only enhances energy recovery but also extends the driving range, offering a practical way to improve sustainability in electric vehicles.

Constraints

- Fit with existing vehicles.
- Weight and Space.
- Safety Regulations

Target Specifications

- Energy output (1.5 – 265) W.
- Weight ≤ 75 kg.
- The microcontroller operating voltage ≤ 7.0 V.
- Maximum mass handled: ≈550 kg per shock absorber.

Objectives

- Energy Recovery
- Light Weight System
- Cost Saving
- Increase Battery Life

Design Calculations

$F_d=C*v$

	F_{dMin} (N)	F_{dMax} (N)
Bumbs	25	350*0.3=105
humps	105	250
Breakers	350*0.3=105	250

$F_s=K*x$, K=250 (N/m)

	$Fs_{,Min}$ (N)	$Fs_{,Max}$ (N)
Bumbs	18.75	25
humps	18.75	25
Breakers	25	50
3 breakers	37.5	56.25
Walk Path	25	50

$F_s=K*x$, K=250 (N/m)

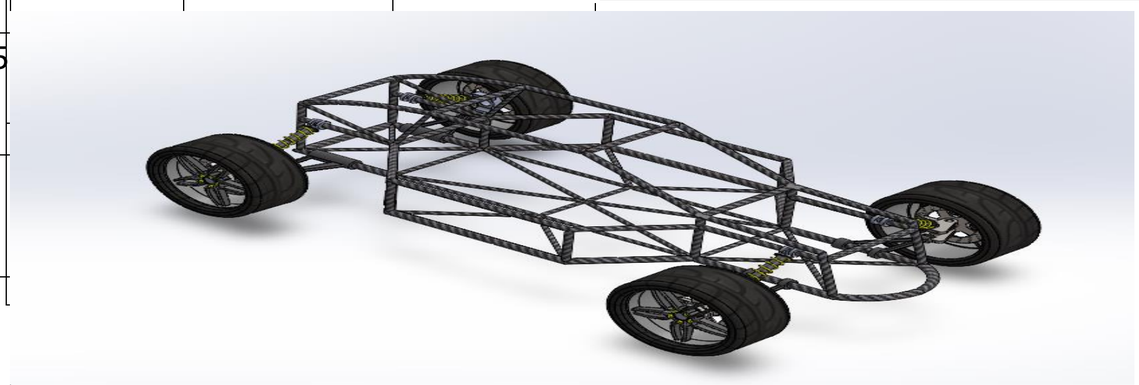
	$Fs_{,Min}$ (N)	$Fs_{,Max}$ (N)
Bumbs	2.5	31.5
humps	31.5	125
Breakers	31.5	125
3 breakers	225	375
Walk Path	2.5	2.5

$P_{out}=P_{in}* \eta$, η=0.7

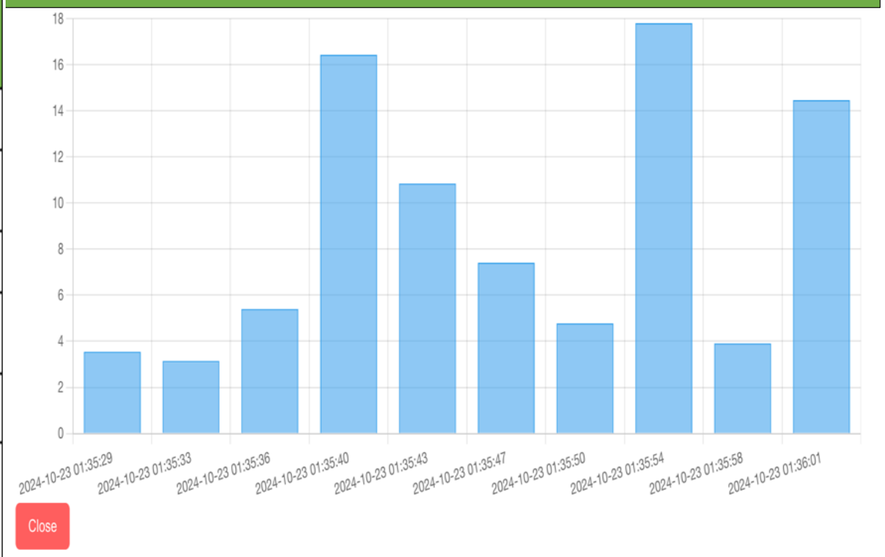
	$P_{out,Min}$ (w)	$P_{out,Max}$ (w)
Bumbs	1.75	22.05
humps	22.05	87.5
Breakers	22.05	87.5
3 breakers	198.45	262.5

	Constraints/Specifications: Met YES	Constraints/Specifications: Met NO
F_{max} (N)	56.25	250
σ_{Max} (KPa)	79.577	353.678
σ_{Min} (KPa)	0	0
σ_m (KPa)	39.789	176.893
σ_a (KPa)	39.789	176.893
Goodman Value	2.94*10^-4	1.339*10^-4

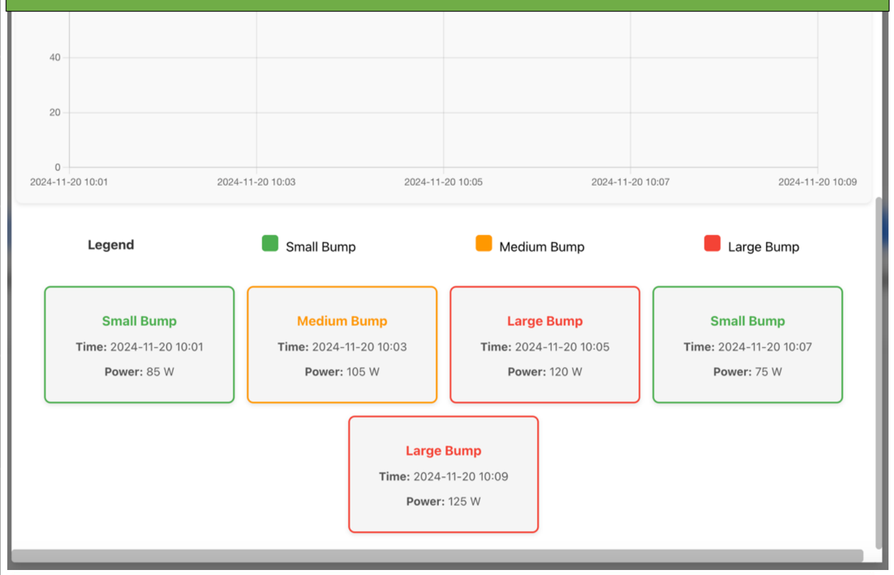
Constrains and specifications	Constraints/Specifications: Met YES	Constraints/Specifications: Met NO
Weight ≤ 75 kg.	Yes, the weight of the system is less than 75 kg.	
The microcontroller operating voltage ≤ 7.0 V.	Yes, the operating voltage is less than 7 v.	
Maximum mass handled: ≈550 kg per shock absorber.	Yes, the material selected is strong.	
Energy output (1.5 – 265) W.		No, but it approximately reaches the beginning of our desired range.
Fit with existing vehicles.	Yes, because we follow standards that every company deals with.	
Weight and Space.	Yes, our system has less components which are only shock absorbers, generators, and rack and pinion. So, it will occupy less space and lose weight	
Safety Regulations	Yes, national standards followed that every company deals with.	



Power-monitoring software with



Road bump prediction, Machine learning program based on power outputs



The ESP32's operating voltage range is 2.2 to 3.6V. Under normal operation the ESP32 Thing will power the chip at 3.3V. The I/O pins are **not 5V-tolerant**! If you interface the board with 5V (or higher) components, you'll need to do some level shifting.

The **3.3V regulator** on the ESP32 Thing can **reliably supply up to 600mA**, which should be more than enough overhead for most projects. The ESP32 can pull as much as 250mA during RF transmissions, but we've generally measured it to consume around 150mA -- even while actively transmitting over WiFi. The output of the regulator is also broken out to the sides of the board -- the pins labeled "3V3." These pins can be used to supply external components.